

# The Relevance of Human Behaviour Representation in Future C2 Systems – Current and Future Research Approaches<sup>1</sup>

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## ABSTRACT

The paper is divided into three parts:

- 1) A general plea for more Human Behaviour Research in the area of military command and control taking into account the recent political and military developments.
- 2) A short discussion on German study projects about Human Behaviour Representation and Organisational Behaviour Representation.
- 3) A proposal for a comprehensive research plan for future analyses, based upon the LTSS on Human Behaviour Representation and the author's own research.

**Key Words:** Human Behaviour Representation, Modelling and Simulation, Training, Operational Analysis.

## 1.0 A PLEA FOR FOCUSED HUMAN BEHAVIOUR RESEARCH IN MILITARY COMMAND AND CONTROL

### 1.1 New Military Challenges

Post-Cold War history is characterised by two new military challenges:

- 1) Frequent peace support and humanitarian assistance operations, to be planned and executed by soldiers who were trained to fight.
- 2) Military operations against “asymmetric” threats posed by “irrationally” acting enemies, to be planned and executed by soldiers trained to fight against military organisations structured and trained on a more or less equal footing.

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<sup>1</sup> This paper would not have reached its actual content and form without intensive discussions with Professor Reiner Huber of the Federal Armed Forces University Munich. His constructive critique and appreciation of Human Behaviour research problems have considerably improved the paper. Our collaboration is a good example of the interdisciplinary work which is indispensable for the assessment of C2 systems.

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These challenges require a new type of soldier. In analogy to the so called Revolution of Military Affairs (RMA) we may speak about a revolution in military qualifications. Both challenges have been met with some success.

- Peace Support Operations (PSO) are basically coalition operations with a wide variety of military and civilian “partners” in unstable environments. Special attitudes and skills are required in PSO. Intercultural and inter-organisational behaviour is about to develop, ethical standards are discussed, political sensibility has become a part of military training on lower command levels. However, systematic analysis and evaluation (i.e. research) is only at the beginning.
- Terrorism may be considered the epitome of the new threats. New approaches are required to fight terrorism some of which are being tested in the Anti-Terror War in Afghanistan: Highly mobile and small teams being part of a real time on-line command and control system and disposing of heavy fire power operate in an almost transparent three-dimensional battle space. What is the challenge of this new threat environment for human behaviour research and representation? Again systematic behaviour analysis and evaluation is indispensable.

So far, hardly any systematic research on these challenges has been undertaken. Whatever success may have been achieved in the field, the underlying doctrine may thus be temporary, awaiting the development of a sound theoretical basis and empirical back-up in order to be sustainable.

## 1.2 Definitorial and Scientific Framework

The scientific discipline addressing the new challenges to military personnel has become known as Human Behaviour<sup>2</sup> Research. Its application in the Modelling and Simulation community is called Human Behaviour Representation (HBR).

Human Behaviour is a *purposive reaction of a human being to a meaningful situation. Representation implies observable concepts and parametric definition* [1]. Human Behaviour Representation’s ultimate purpose is the “optimisation” of behaviour through testing behavioural hypotheses in simulation experiments thus generating behavioural modules, which are to be used in training, mission support and operational analysis. HBR covers essentially all human sciences, their interfaces with technical sciences and in particular informatics and computer sciences, respectively. However, HBR is not a subset of computer sciences, as (e.g.) agent based modelling, it rather entails the human sciences *par excellence*.

## 1.3 Objectives of Human Behaviour Representation

Since there are many individual sciences such as, for example, psychology, cultural anthropology, and cognitive ergonomics involved and the potential use of HBR is manifold (training, mission rehearsal, personnel selection), it is imperative to agree on its fundamental aims and structure in order to provide for effective access to resources (manpower and data) and to avoid duplication of efforts.

The *aims* of HBR research can be defined as:

- “optimal” *exploitation and allocation* of the mental capacities of military decision makers on *all* command levels
- “experimentation” with behaviour models in virtual environments throughout all major military activities.

The *structure* of HBR resembles that of interdisciplinary and applied research that requires the co-operation among the scientific disciplines involved as well as with the users of the research results.

<sup>2</sup> The term “behaviour” is used very broadly. “Behaviourism”, a school of psychological thinking, is not necessarily implied.

This is most importantly an *intra*-organisational task within the responsibility of the military customer. Any design of applied research *not* involving human sciences *and* technology *and* the user domain knowledge right from the beginning is prone to fail. This assertion may sound trivial, however, entails non-trivial organisational problems. The HBR team-building in military organisations needs high level support to be effective, because it requires the collaboration of scarce operational manpower and cuts across all command levels and many major commands.

### 1.4 Structure and Usage of HBR

There are two different kinds of behaviour: *intra*-personal “behaviour” and *inter*-personal behaviour. With the two new military challenges discussed above, four areas of HBR issues can be distinguished. Each of them entails distinct research issues, which need to be defined and structured based on a consensus of the disciplines and knowledge domains in question. The interdisciplinary collaboration begins with the definition of the problem.

The following research problem areas, regarded to be of some urgency:

- Impact of different *leadership styles* on the effectiveness of missions (in PSO, in conventional warfare and in asymmetric warfare, and about the implications of sudden changes in these mission paradigms).
- *Mental dispositions* and *training* to cope with the sudden change of mission paradigms (e.g. from PSO to full blown combat).
- *Group-think syndrome*, for team decisions, especially when the group dynamics are not transparent, so that one does not know why a group reacts the way it actually does.
- The new kind of stressors and stress coping strategies in PSO and asymmetric warfare. There are, however, many individual stress research projects, but little is known about large scale (longitudinal and long term) research projects on complex, realistic cognitive challenges under stress in military environments [2].
- *Motivation* Structure of military leaders – along the lines of the so-called “Reiss-Profiles [3]”. Motivation is the primary factor of decision making and acting. The Reiss-Profiles tell us (e.g.) that “Vengeance”, “Family” and “Order” are the three highest motivational factors of the average middle-class American, whereas “Citizenship”, “Power” and “Independence” rank lowest. Are there similar or different profiles in the military population?

Psychology is considered to be the core discipline for HBR. Important assertions of psychological research relevant for HBR can be roughly summarised as follows:

- The nature of knowledge acquisition is *constructivistic* [4]: Knowledge is socially shared model building in contexts. Every individual knowledge is context-dependent and defined by the individual and social history of the individual. This means: that HBR agents (i.e. models) must be programmed as *learning “automata”* socially interacting with other “models” and with a changing environment. Different agents must have different learning histories. Today, HBR methodology hardly acknowledges this requirement.
- Group behaviour research [5] aims at enhancing team effectiveness, at avoiding mistakes in intra-team communications, and at creating favourable team environments. For HBR this means that: modelling of group behaviour must address *shared group goals and group memory* as the primary entity to be modelled explicitly, and not merely group structure or what is often called “coherence”.
- Decision making, or better, choosing between alternative courses of action, is the product of motivational, emotional and cognitive factors. It is not an outcome of “rational” choice such as

deciding between different probabilities of success, because the evaluation of probabilities is based on individual rationales and, therefore, implies a subjective act. The German study project presented next may well serve as an example.

## 2.0 GERMAN STUDY PROJECTS

So far HBR research in Germany was dealing with intra-personal decision making in PSO. It resulted in a new psychological concept of decision making in critical situation based upon which a process model of choosing among different courses of action was developed.

The model works with five major psychological constructs: motivation, schema-based action, self-efficacy, emotional stability (neuroticism-scale) and a reversed “Rasmussen scale”.

Extensive tests of this model have demonstrated that individual behaviour described in these terms and its impact on critical situations, can indeed be modelled. Different individuals affect situations differently, and the model illustrates how this works in simulation.

The demonstration model is based on a typical PSO micro-scenario: apprehending and disarming a gun-man. Different options to act, e.g. negotiation or the controlled use of force, are chosen by the HBR module according to how the simulated person's psychological structure is defined. In addition, the demonstration model permits to generate circumstances when the situation may get out of control. Psychological effects, different courses of action and outer world effects (e.g. obstacles, stressors) as well as direct and indirect outcomes are modelled. The demonstrator proves that a *complex* psychological behaviour model can indeed be implemented in military simulation systems. Figures 1 and 2 provide an overview of the formal structure of a micro scenario and the HBR module.

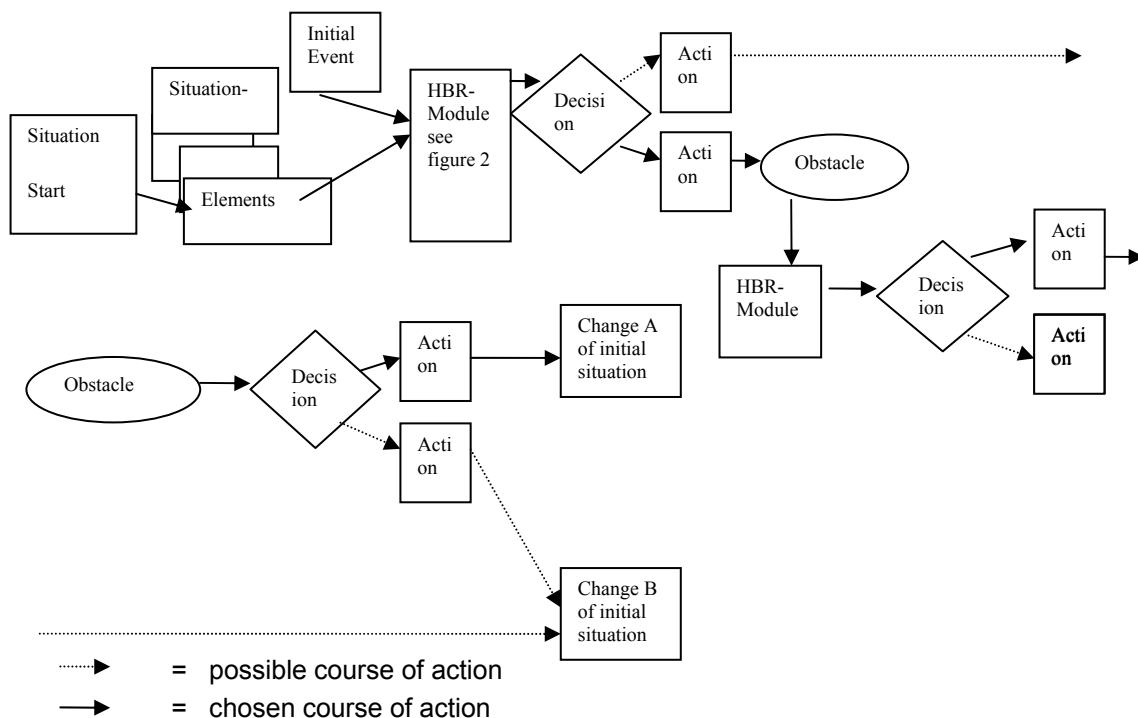
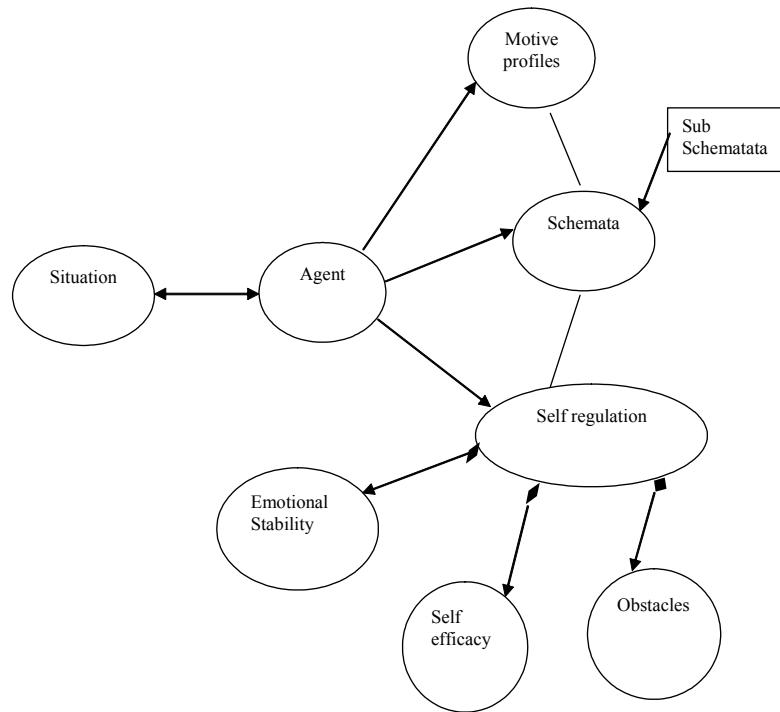


Figure 1: Micro Scenario with HBR Module.



**Figure 2: HBR Module (Simplified).**

After the principal feasibility of intra-personal HBR has been demonstrated, the upcoming research will address *Organisational Behaviour Representation*, i.e., the question of decision making processes in small groups as well as entire bureaucratic institutions. In addition to the aspect of individual behaviour addressed in the first project, social-psychological (group dynamics) and organisational issues will have to be considered. The research objective is to develop a group-decision making approach addressing decisions in combat as well as in OOTW situations. It is presumed that the main differences lie in the way stressors and social cognition are relevant.

In this context, several fundamental questions need to be investigated, such as:

- Does the military definition of team work and team decision differ from non-military definitions?
- How far supersede military roles and procedures the common way of group interactions?
- What happens when neither of two groups (a military and a non-military) can, in a *common* situation, define a *common* task?
- Do military groups or individuals change their norms and habits when they are confronted with alternative norm-systems, e.g., when they fight together with or against “asymmetric” organisations? How to cope, generally, with norm-conflicts?

### **3.0 POSTULATES AND ELEMENTS OF A COMPREHENSIVE RESEARCH PLAN**

Two years ago, the LTSS on HBR [6] recommended a set of research activities which are still valid but need updating. *Very high* priority was accorded to the following:

- Establish an infrastructure that co-ordinates and facilitates the research on human behaviour modelling (e.g. virtual institute, testbed for demonstrating and studying composability/interoperability of models).

- Establish a new research effort (e.g. a NATO RTO Specialist Team) on a research plan for team, group and organisational modelling research.
- Establish an additional effort (e.g. a NATO RTO Task Group) to characterise best practice in HBR validation.

LTSS recommendations accorded *high* priority pertain to special problems, most of which are covered by the research goals proposed above, namely:

- adaptive-intelligent coaching
- model of goal-oriented information
- processing (acquisition, evaluation and selection) capabilities and strategies
- automated explanation of behaviour
- reuse of knowledge.

The findings of SAS 017 support the conclusions derived from the author's research in the past two years. Accordingly, there are four practical *postulates* which make Human Behaviour research effective:

- 1) *Context Centred Modelling*: Don't attempt to "model the human". In other words, do not strive for a general world model of human behaviour in military operations. Some researchers try to do that. However, while such an effort may be of significant value in artificial intelligence research and provide insights useful for applied research, community of applied sciences modelling should always revolve around a well defined context.
- 2) *Relevance*: Whenever empirical data are required or used, they should be based on well established psychological and sociological theories and capable to explain common sense experience. In other words, data must be empirically and scientifically relevant.
- 3) *Face Validity*: Do research on processes in a "molar" manner, i.e., in rough granularity and meaningful contexts, not black box input and output analysis and definitely not singular case analysis without general interest. Use typical situations and phenomena and try to define quantifiable processes with a rough predictive value.
- 4) *The litmus test of behavioural research is its value for simulation*: Analyse the possibilities and limitations of simulation in any given research project and try implement research findings in simulation models and reproduce them in simulation experiments. It should be pointed out, however, that many an academic researcher would not subscribe to this postulate which is indispensable for the applied research community.

If we combine the recommendation of the LTSS on HBR with what we found when analysing the impact of Human Behaviour research, we come to a logical sequence of four research *elements*:

- 1) Recognise *problem spaces*, where Human Behaviour research can help. A problem space is a multi-dimensional set of inter-related uncertainties. As an example one might consider how to train soldiers of lower rank in coping with decision problems when world wide media coverage is present and the ethical or political mission success depends on his or her action without any chance to ask for superiors' direction. This is a common situation in almost any PSO mission and a fine example of the subjective construction of social reality. A relatively small event may create a big problem; it entails plenty research issues.
- 2) The concrete need for human science support should be reflected in a *typical scenario* definition per problem-space which exemplifies the need to find solutions. The scenario must contain descriptions of actors, recipients (victims) of actions, alternative courses of action. The actors must be defined in terms, which make it possible to identify the sciences involved.

For example, a decision under media coverage entails at least three scientific challenges: 1) situational and cultural awareness, 2) knowledge about the design and impact of media presentation, 3) decision making under stress. Actors are the particular soldier in question and his comrades, the media “counterpart”, a representation of his superiors, a representation of the people and the politics at home. Sciences involved are Cognitive Psychology, Political Science, and Media Impact Research.

- 3) Compose a team of *scientific experts and military users*<sup>3</sup>. The team should be led by a scientific generalist, who acts as a team moderator and facilitator. The team must become an “expert team” i.e. develop a consolidated knowledge base to solve the pertinent problem-space and push the solution so far as to serve as a basis for Modelling and Simulation. This means that the conceptual work must yield quantifiable constructs and relatively simple production rules. Military research needs robustness and sustainability as any ordinary military operation.

### 4.0 RESEARCH AREAS FOR HBR

The following problem spaces are proposed for discussion. They are grouped in four research areas distinguished in section 1.4.

#### *Intra-personal behaviour in “asymmetric” situations:*

- Research on cultural and socio-economic situations which may lead to *hostile feelings* and eventually to the outbreak of asymmetric hostilities: Why do they hate us and what can we do about it?
- Match or discrepancy of the *mental models* about typical soldier behaviour: Are they really different from us?

#### *Inter-personal behaviour in “asymmetric” situations:*

- Asymmetry seen as a *cultural* problem and not just as a difference of combat capabilities: What is *asymmetry*?
- Mental and *behavioural adaptation* to asymmetric opponents: Do we have to become like them?
- *Non-combat interaction strategies* in asymmetric conflicts: How to influence them?

#### *Intra-personal behaviour in OOTW situations:*

- Are the *mental requirements* for “warriors” the same as for “peace keepers”? Can we meet both challenges with the same manpower?
- *Qualifications* to change suddenly from war behaviour to OOTW behaviour and vice versa.

#### *Inter-personal behaviour in OOTW situations:*

- Social *definition of the situation* in negotiations with non-military or ethnically different organisations.
- Any sort of research into the functioning of Non-Government *Organisations*, in order to improve collaboration.

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<sup>3</sup> What is standard in software development, namely the principles of “usability engineering”, should also be standard in the scientific model development.

There is much to be done. Most of all, the definition of relevant and important research requires close interaction between the OR/SA and Human Behaviour Sciences community. Early interaction is absolutely essential in studies to support C2 assessment in the new mission environment.

## **5.0 REFERENCES**

- [1] Cf. Final Report LTSS on HBR, Chapter 2.
- [2] Cf. Rainer H. Kluwe, Stress und Kognition, Interim Report prepared for the German MoD, Hamburg 2001.
- [3] St. Reiss and S.M. Havercamp, Toward a Comprehensive Assessment of Fundamental Motivation: Factor Structure of the Reiss Profiles, in: Psychological Assessment, 1998, Vol. 10, No. 2, pp. 97-106.
- [4] Cf. for example J. Gerstenmaier and H. Mandl, Wissenserwerb unter konstruktivistischer Perspektive, in: K. Pawlik (Editor), Bericht über den 39. Kongreß der Deutschen Gesellschaft für Psychologie in Hamburg 1994, Göttingen 1995, pp. 362-367.
- [5] Cf. e.g. E.H. Witte, Zum Stand der Kleingruppenforschung, in: Pawlik (see fn. 5), pp. 464-469.
- [6] RTO Technical Report: TR-047: Human Behaviour Representation, AC/323(SAS-017)TP/25.

## Human Behaviour Representation in Future C<sup>2</sup> Systems

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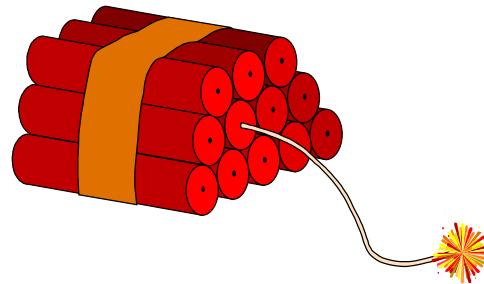
# The Relevance of Human Behaviour Representation in Future C<sup>2</sup> Systems Current and Future Research Approaches

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## Human Behaviour Representation in Future C<sup>2</sup> Systems

### New Military Challenges

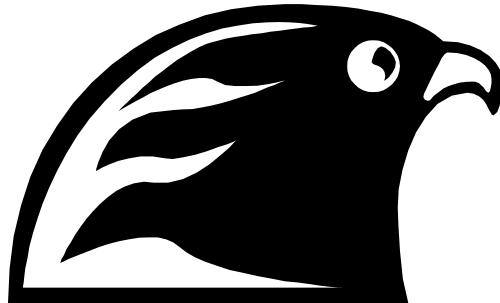
- Peace support and humanitarian assistance operations
- Military operations against "asymmetric" threats



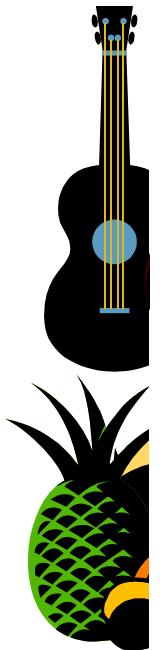
## Human Behaviour Representation in Future C<sup>2</sup> Systems

### Revolution in military qualifications

- Intercultural and inter-organisational behaviour, ethical standards, political sensibility



- Real time on-line command and control, almost transparent three-dimensional battle space



## Human Behaviour Representation in Future C<sup>2</sup> Systems

### Definitorial and Scientific Framework

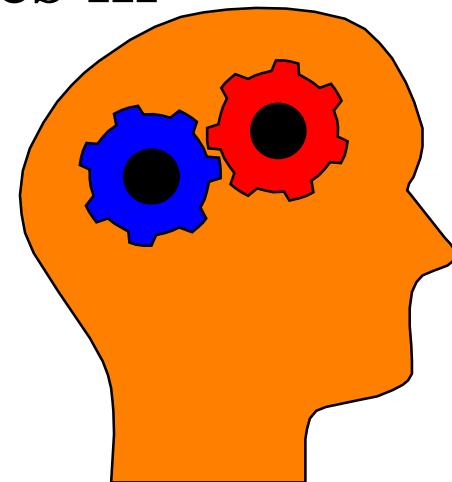
- Human Behaviour is a purposive reaction of a human being to a meaningful situation
- Representation implies observable concepts and parametric definition



## Human Behaviour Representation in Future C<sup>2</sup> Systems

### Definitorial and Scientific Framework

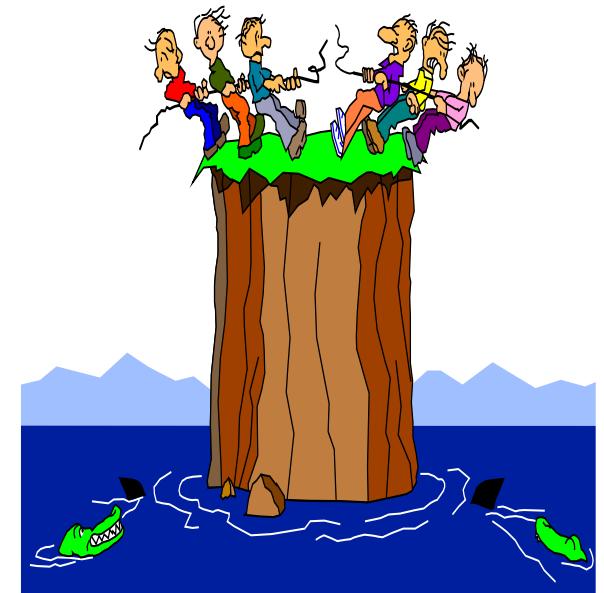
- Purpose:  
*“Optimisation” of behaviour*
- Testing behavioural hypotheses in simulation experiments
- Behavioural modules in training, mission support, operational analysis



## Human Behaviour Representation in Future C<sup>2</sup> Systems

# Objectives and Structure of Human Behaviour Representation

- Objectives: Exploitation of mental capacities
- Structure: Interdisciplinary and intra-organisational task



## Human Behaviour Representation in Future C<sup>2</sup> Systems

### Research Problem Areas

Main distinction: *intra-personal* and *inter-personal* behaviour

- Leadership styles
- Mental dispositions and training
- Group-think syndrome
- Stressors in PSO and asymmetric warfare
- Motivation of military leaders

## Human Behaviour Representation in Future C<sup>2</sup> Systems

### Psychological Research Relevant for HBR

- Constructivistic approach
- Team effectiveness
- Decision making = product of motivational, emotional and cognitive factors



## Human Behaviour Representation in Future C<sup>2</sup> Systems

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### German Study Projects

#### 1. HBR Module for C<sup>2</sup>

Five psychological constructs: motivation, schema-based action, self-efficacy, emotional stability and a reversed "Rasmussen scale"

#### 2. Organisational Behaviour

#### 3. Mass Behaviour

## Human Behaviour Representation in Future C<sup>2</sup> Systems

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**Typical Small Scenarios with HBR**

**„Leading a Convoy in PSO“**

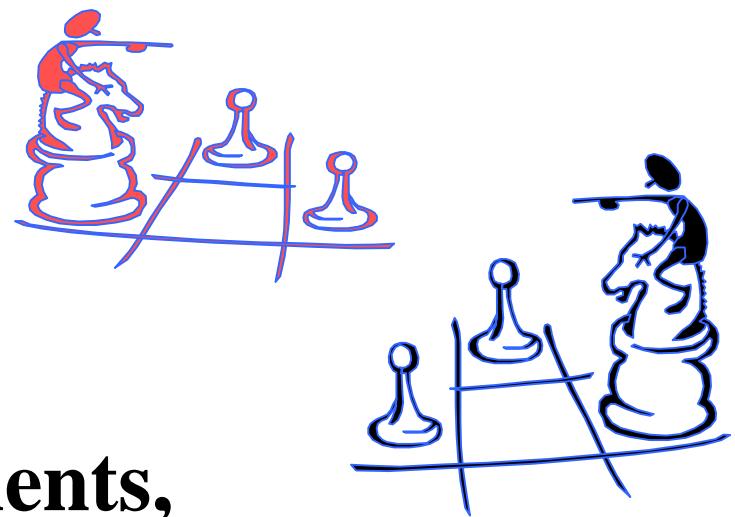
**„Apprehending  
and Disarming“**

**One Person decides**



## Human Behaviour Representation in Future C<sup>2</sup> Systems

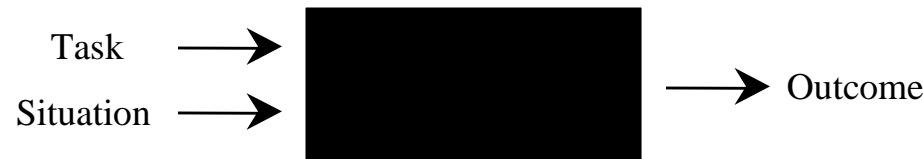
- Action goal
- Agent module, Process module  
(invariable and variable conditions)
- “Recipient” module
- 1 agent, 1 recipient,
- Almost 40 scenario segments,
- Over 20 decisions, near and a far reaching effects of every decision



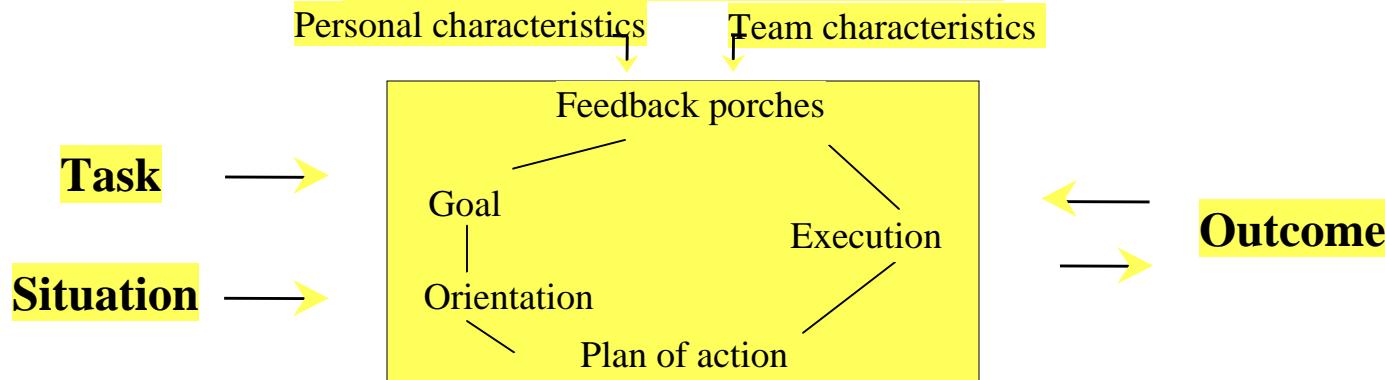
## Human Behaviour Representation in Future C<sup>2</sup> Systems

### Conditions of Model Building

#### Black-Box-Model



#### Behavior Process Model



## Human Behaviour Representation in Future C<sup>2</sup> Systems

### Motives

- Performance motive
- Help motive
- Might and imposition motive
- Social acceptance motive
- Personal security motive
- Aggression motive
- Individual strength of motives



## Human Behaviour Representation in Future C<sup>2</sup> Systems

### Schemata

- Task accomplishment schema
- “How to help” schema
- “How to delegate responsibilities” schema
- “First ask for directions” schema
- Negotiations schema
- Use of force and escalation schema
- Individual strength of schemata
- Three regulation levels



## Human Behaviour Representation in Future C<sup>2</sup> Systems

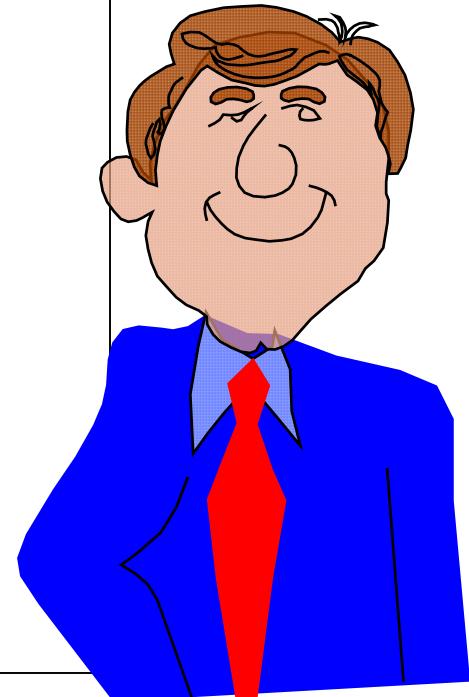
### Regulation Levels

- Knowledge Based Behavior
- Rule Based Behavior
- Automatic Behavior (Emergency)
- Schemata are different according to these levels
- Some Schemata are only Emergency Behavior

## Human Behaviour Representation in Future C<sup>2</sup> Systems

### Self Regulation

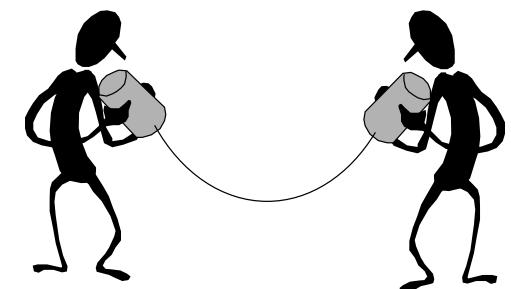
- Emotional Stability
- Self efficacy
- Evaluation of action success
- Affect and  
Coping with Stress



## Human Behaviour Representation in Future C<sup>2</sup> Systems

# Organisational Behaviour Representation

- Definition of Team Work and Team Decision
- Military Roles and Procedures
- Definition of the Situation
- Change of Norms and Habits



## Human Behaviour Representation in Future C<sup>2</sup> Systems

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### Research Plan

#### Postulates and Elements:

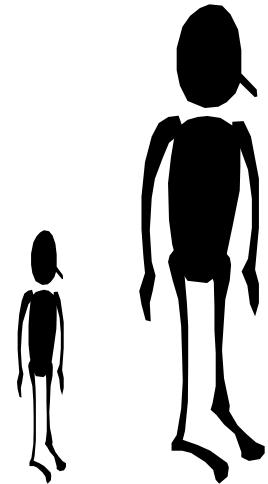
- LTSS on HBR Recommendations
- Context Centred Modelling
- Scientific Relevance
- Face Validity
- Simulation !



## Human Behaviour Representation in Future C<sup>2</sup> Systems

### Problem Spaces in Asymmetric Warfare

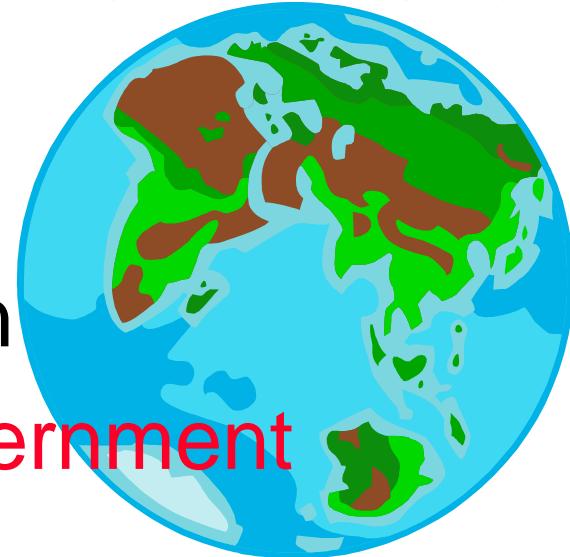
- “Hostile Feelings”
- Mental Models
- Asymmetry as a *Cultural* problem
- Behavioural adaptation to asymmetric opponents
- Non-combat interaction strategies



## Human Behaviour Representation in Future C<sup>2</sup> Systems

### Problem Spaces in OOTW

- Mental requirements for “warriors” and for “peace keepers”
- Qualifications
- Definition of the situation
- Functioning of Non-Government Organisations



## Human Behaviour Representation in Future C<sup>2</sup> Systems

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**There is much to be done**

